

Typology of Non-industrial Private Forest Owners in Tasmania

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The heterogeneous nature of non-industrial private forest (NIPF) owners and the challenge this heterogeneity presents for effective policy and program design and delivery is widely recognised. Understanding the socio-economic and motivational differences between various types of landowners will better equip policymakers and forest extension professionals to design policies and programs that efficiently promote private sector timber production and forest conservation outcomes. The purpose of this study was to develop a survey-based empirical typology of Tasmanian NIPF owners based on their stated objectives of forest ownership and to relate owner type to a range of observable property and owner characteristics as well as to timber harvesting and forest management behaviour. Using principal component analysis (PCA) followed by means cluster analysis, four distinct groups are identified: *income and investment owners*, *non-timber output owners*, *agriculturalists*, and *multi-objective owners*. Members of these groups are found to differ significantly in terms of their personal and property characteristics, as well as their timber harvesting and management behaviour. For example, members of the *non-timber output owners*, who are motivated solely by objectives related to the production and protection of the non-timber outputs of forests, have similar proportions of timber on their property, but are less likely to have harvested timber from their property, than all other groups.

Keywords: objectives of forest owners, timber harvesting behaviour, principal components analysis, logit and probit models

INTRODUCTION

About 26% of the total forest area in Tasmania is located on privately owned land. These forests cover 15% of the total land area of Tasmania and account for about 50% of the State's total timber production each year (Private Forests Tasmania 2002). These forests also represent a rich source of environmental services and other conservation values (Tasmanian Public Land Use Commission 1997, Parsons 1999, Gluck 2000). The importance of non-industrial private forest (NIPF) owners as both timber producers and forest managers, and as stewards of conservation values, is recognised in Australia and internationally. This is reflected in the wide range of policies and programs initiated across all levels of government aimed either at encouraging the development and management of private forests for their timber

values, or at promoting and protecting the environmental and other non-use benefits of forests through reservation, reforestation and the maintenance of native vegetation (see Herbohn *et al.* 2000 for a full review of programs).

Historically, the effectiveness of these initiatives in securing socially desirable timber production and management, and conservation outcomes, has been variable (James 1997). NIPF owners differ markedly in terms of their personal and property characteristics and the social, economic and cultural environments in which they operate. International evidence suggests that they also differ in terms of their values, attitudes, and forest ownership objectives (Karppinen 1998). It is to be expected that this diversity will be reflected in varying levels of participation in timber markets and involvement in forest management across NIPF owners, and that individual owners will respond to forest production and conservation programs and incentives in a variety of ways.

Our motivation for developing the Tasmanian landowner typology presented here has been to construct a variable that captures underlying landowner motivations for inclusion in an econometric study of timber harvesting behaviour (Jennings and van Putten, forthcoming). No previous study in Tasmania had included such a variable in a logit model of the probability of a landholder choosing to sell timber in the future, and in a tobit model in which the effect of stumpage price on the continuous decision to harvest pulp is developed.

More generally, however, there is a clear need for a better understanding of the way in which different types of forest owners make decisions and the factors affecting their forest harvesting and management behaviour. This will help public policy-makers and planners design and implement incentive schemes and programs that, by accounting for the heterogeneity among NIPF owners, more effectively cater to the needs of particular owner types. Forest industries should also benefit from an improved understanding of the forest ownership objectives of the NIPF timber growers upon whom they may rely for resource (Karppinen 1998), and with whom they may wish to engage in joint production arrangements.

NIPF CLASSIFICATION STUDIES

The harvesting behaviour of NIPF owners has been the subject of many studies in Northern Europe, the United States, Canada and, more recently, in Australia. The effect of forest owner and ownership characteristics on harvesting behaviour was investigated by Binkley (1981), Jamnick and Beckett (1988), Clements and Jamnick (1989), MacFarlane (1994), Wear and Parks (1994), Salkie *et al.* (1995) and Jennings and van Putten (2001). The relationship between these characteristics and forest investment has been explored in Romm *et al.* (1987). Gramann *et al.* (1985) examined the influence of past harvesting experience on future intentions, and the effect of price on timber supply has been studied by Adams and Haynes (1989), Newman and Wear (1993), Kuuluvainen *et al.* (1996) and Karppinen (1997). While these studies have confirmed the importance of a wide range of observable economic and non-economic variables in explaining the harvesting behaviour of NIPF owners, a large part of the variation in this behaviour generally

remains unexplained and many aspects of NIPF owners' decision processes have not been adequately explored.

The development of landholder typologies to advance our understanding of how variation in landowners' characteristics affects land management and behaviour has been a focus of Australian researchers over many years. A review of the different typologies and how they are used to assist in the design and delivery of programs is presented by Emtage *et al.* (in press). The current review focuses on typologies for NIPF owners in relation to forest harvesting and management.

The need to include forest owners' objectives for, and attitudes towards, their forests as explicit explanatory variables in empirical studies of forest harvesting and management behaviour is widely acknowledged. The objectives of forest ownership have been investigated by Kurtz and Lewis (1981), Egan and Jones (1993), Kline *et al.* (2000), Bohlin and Roos (2002) and Erickson *et al.* (2002), among others. In Australia, rural extension and communication research has stressed the importance of the socio-economic circumstances and attitudes of landowners in explaining land-use decisions in general and the adoption of farm forestry in particular (Race and Curtis 1997, Race and Fulton 1999). Emtage *et al.* (2000) identified groups of Queensland landowners with similar attitudes to farm forestry, as revealed by the importance they placed upon various reasons for planting trees and the importance of different impediments to planting trees, using cluster analysis. The five groups formed were then aligned with landholder types as described by extension personnel and used as the basis for recommending the design of farm forestry support schemes. Emtage *et al.* (2000, 2001) found that the groups formed on the basis of their attitudes differed in terms of a number of socioeconomic characteristics and in terms of the present and past forest management behaviour.

The link between forest ownership objectives and harvesting and silvicultural behaviour in Finland was explored in Karpinnen (1997, 1998) and Kuuluvainen *et al.* (1996). Karpinnen (1998) identified four distinct types of Finnish forest owners and concluded that they differ in terms of both personal and property characteristics, and in terms of their timber cutting and silvicultural behaviour. Multiple objective owners, who manage their forestland for both their monetary and amenity benefits, were found to be the most active group with respect to cutting and silvicultural activity.

In the study reported here, data on the objectives of forest ownership of 386 NIPF landowners are used as a basis for identifying a typology of NIPF landowners. The landowner types are then linked to observable personal and property characteristics, and differences in past and intended future forest harvesting, and production- and conservation-related management behaviour between these groups are explored. While the findings are intended to be of immediate practical interest to forestry extension professionals, the research motivation has been to include 'landowner type' as an explanatory variable in the econometric analysis of NIPF timber supply in Tasmania.

The next section of the paper describes the 2001 Forest Owner Intention Survey, including the question on forest owner's objectives, on which this paper is based. In the following section, the research methods used both to identify landowner groups and to explain group membership are discussed. The results of the empirical analysis are then reported and discussed.

THE TASMANIAN FOREST OWNER INTENTION SURVEY

A Forest Owner Intention Survey (FOIS) was carried out in Tasmania in October 2001 with the general aim of better understanding the intentions of private landowners in relation to forestry activities and assessing timber harvesting potential on private land¹. To select the sample, a total of 2,000 randomly placed sample points were projected onto a combined private land tenure and forest cover map of Tasmania, with sample point placement restricted to non-industrial privately owned land with forest classified as 'native forest'. The Universal Property Index for each sample point was recorded and the address of the landowner was obtained. A total of 1,973 sample points were located and ownership details obtained. Of the original 2000 sample points, 27 were not used due to minor inaccuracies in the dataset, while 497 sample points were located on 188 properties that contained more than one sample point. The final sample consisted of 1,664 property owners. Following testing, the questionnaire was mailed out in October 2001. No follow-up procedures were implemented. A total of 482 useable questionnaires were returned, representing a 30% response rate by property owners. Comparison of some key socio-economic characteristics (including age and property size) of those sampled to general ABS data for Tasmanian landowners suggested that the survey sample was broadly representative.

Respondents were asked to complete a total of 48 questions that were organised into three sections. Section 1 asked questions aimed at establishing general property characteristics, past logging and management activity, and future logging intentions for the property. Section 2 related to forestry activity on a particular tract of forestland on the property as identified on a map that was attached to the questionnaire. Section 3 sought personal information about the landowner (including gender, age, income and educational status), the source and type of information about forestry received by the landowner, and the landowner's objectives of forest ownership.

The final question asked respondents to rate 18 objectives of forest ownership according to their importance, using a five-point Likert scale ('not important' to 'very important'). The wording of the question was 'How important are each of the following objectives of forest ownership to you?' The list of ownership objectives was adapted from Kuuluvainen *et al.* (1996) to suit Tasmanian circumstances and included a range of monetary, environmental, recreational, emotional, aesthetic, agricultural and other land management objectives.

Of the 482 questionnaires returned, 81 respondents failed to rate between one and 17 of the forest ownership objectives. Overall, 53% and 51% of these respondents did not give a rating to 'on-farm employment' and 'aesthetic value' respectively, which may suggest that many landowners are not familiar with the meaning of these terms. A further 15 respondents either failed to complete one or more of the key

¹ This survey is conducted approximately every five years by Private Forests Tasmania (PFT) and the results are used as the basis for meeting PFT's reporting requirements to the National Forest Inventory, for preparing estimates of NIPF timber availability and for assisting in meeting PFT's statutory functions. The 2001 survey was undertaken jointly with the authors of this paper and forms the basis of an economic timber supply study in the State.

questions regarding property or owner characteristics or harvesting behaviour. Consequently, 96 of the original 2002 FOIS responses were excluded, the analysis of landowner objectives being based on a sample size of 386².

RESEARCH METHOD

The 18 variables describing forest ownership objectives were condensed using principal component analysis (PCA) and rotated using the VARIMAX method to form a reduced number of interpretable variables (following Kaiser 1958, Mulaik 1972). Component analysis, first proposed by Pearson (1901) and fully developed by Hotelling (1933), is a multivariate technique that reduces a large body of data so that a maximum of the variance is extracted (Harman 1967). More formally, the object of component analysis is to represent a variable, Z_j , in terms of several underlying factors, or hypothetical constructs. The model for component analysis is:

$$Z_j = a_{j1}F_1 + a_{j2}F_2 + \dots + a_{jn}F_n \quad (j = 1, 2, \dots, n) \quad (1)$$

Each of n observed variables is described linearly in terms of n new uncorrelated components F_1, F_2, \dots, F_n . An important property of this method, insofar as the summarisation of data is concerned, is that each component in turn makes a maximum contribution to the sum of the variances of the n variables. The sum of the variances of all n principal components is equal to the sum of the variances of the original variables.

PCA yields a matrix of correlations between rating variables and factors. Individual-level PCA scores were used as criterion variables for grouping, or clustering, NIPF landowners using the K-mean clustering method.

The number of clusters (K) into which the data are to be grouped is determined prior to the analysis. The cases are initially assigned randomly to the K clusters. Cases are then moved around between clusters iteratively in order to minimise some measure of cluster variability. More formally, the heterogeneity between the data for a given partition $P(M, K)$ of M cases into K clusters, where each of the M cases lies in just one of the K clusters, is measured by an error $e[P(M, K)]$. Suppose the i^{th} case of the j^{th} variable has value $A(i, j)$, for $i = 1, \dots, M$ and $j = 1, \dots, N$. The mean of the j^{th} variable over all the cases in the l^{th} cluster, for $l = 1, \dots, K$, is denoted by $B(l, j)$. The number of cases in the l^{th} cluster is $N(l)$. The distance between any two clusters n and l is:

$$D(I, L) = \left(\sum_{j=1}^N [A(I, j) - B(L, j)]^2 \right)^{1/2} \quad (2)$$

² t -tests of differences in sample means and proportions were used to establish whether there was a difference between respondents who were included and those who were excluded from the analysis. Significant differences were found for only three of more than 30 variables and indicated that members of the excluded group owned larger properties and were more likely to be male and less likely to have attained a university education than those included.

and the error of the partition is:

$$e[P(M, K)] = \sum_{i=1}^M D[I, L(I)]^2 \quad (3)$$

where $L(i)$ is the cluster containing the i^{th} case. The general procedure in K-means clustering is to search for a partition with a small error by moving cases from one cluster to another. The search ends when no such movement reduces e (Hartigan 1975).

Statgraphics Plus Version 5.0 has been used in this study to analyse the variance between and within groups for the continuous variables. Following transformation of the data, a multiple comparison procedure is used to determine the landholder group means that differ from other landholder group means. SPSS has been used to test for differences in the mean values of discrete variables.

LANDOWNER OBJECTIVES GROUPS

The 18 original variables describing a range of landowner objectives were reduced to four principal components using the PCA function in SPSS. The eigenvalue of all subsequent components was less than one. The explained proportion of the total variation of the original variables of these four components was 56.9%³. A Kaiser-Meyer-Olkin measure of sampling adequacy, which compares the magnitudes of the observed correlation coefficients to the magnitude of the partial correlation coefficients (following Malhotra 1999), is 0.833, suggesting that using factor analysis on this data set is appropriate.

The interpretation and naming of the four principal components is based on an examination of the objectives with the highest loadings as reported in Table 1. The first component (PC1) has high loadings for all of the non-market environmental, aesthetic and spiritual objectives, and the private outdoor recreation objective. It also has a high loading for tourism value, a non-consumptive use of the forest. This component is interpreted to represent a '*non-timber output motive*' and explains 23.6% of the total variation of the original variables.

The second component (PC2) has high positive loadings for all of the financial objectives. These objectives reflect the effect of forest ownership on both current income and property values and on future asset values. The factor loading for aesthetic value is negative. The loadings suggest a strong '*financial motive*' for owning forests. The second component explains 13.3% of the total variation of the original variables.

³ Using the same methodology, Kline *et al.* (2000) and Karppinen (1998) both identified three principal components, these explaining 62% and 43% of the variance of the original variables respectively.

Table 1. Results of principal component analysis with VARIMAX rotation of forest owner objectives (n = 386)

Ownership objective	Principal component labels			
	PC1	PC2	PC3	PC4
	Non-timber output motive	Financial motive	Whole-of- farm value motive	Household use motive
	Factor loadings ^a			
Property value	*	0.541	0.400	*
Biodiversity conservation	0.743	*	*	*
On-farm employment options	*	*	0.749	*
Water quality	0.561	*	*	*
Farming diversification options	*	*	0.789	*
Spiritual / sentimental value	0.659	*	*	*
Aesthetic value	0.742	-0.258	*	*
Private outdoor recreation	0.640	*	*	0.371
Stock grazing values	*	*	0.616	0.491
Household firewood / timber supply	*	*	*	0.834
Security for old age/ times of hardship	*	0.643	*	0.322
Wildlife habitat	0.748	*	-0.330	*
Source of income	*	0.534	0.536	*
Tourism value	0.558	*	*	*
Reduced risk of land degradation	0.707	*	*	*
Easily cashed in asset	*	0.787	*	*
Landscape value	0.752	*	*	*
Speculative asset	*	0.721	*	*
Eigenvalue	4.251	2.394	2.262	1.340
Percentage of variance explained	23.62	13.30	12.56	7.44

Kaier-Meyer-Olkin statistic = 0.833.

^a Only factor loadings exceeding 0.250 are reported. Loadings below 0.250 are denoted by an asterisk.

Objectives dealing with whole-of-farm management, including on-farm employment, diversification options and stock grazing values, are highly loaded on the third component (PC3). Property value and source of income also have reasonably high loadings on this component. The factor loading for wildlife habitat is negative. This component, which explains 12.6% of the total variation of the original objectives, has been named '*whole-of-farm motive*'.

The fourth component (PC4) has a particularly high loading for household firewood/timber supply. The importance of private outdoor recreation, stock grazing and providing security for old age is also indicated. This component explains 7.4% of the total variation and has been labelled '*household use motive*'.

The unique factor scores for each respondent were used as the grouping variables in a K-means cluster analysis. The aim was to identify groups of forest owners on the basis of their systematic recognition of the importance of various forest ownership objectives. The analysis suggests that NIPF landowners in Tasmania can

be classified into four groups as shown in Table 2. Cluster, or group, labels generally reflect the forest ownership motives associated with the principal components with the highest positive score.

Table 2. Results of cluster analysis of landowners based on individual-level factor scores

Principal component	Cluster labels			
	C1 Income and investment owners	C2 Non- timber output owners	C3 Agricul- turalists	C4 Multi- objective owners
	Mean of factor score			
PC1 - (Non-timber output motive)	-0.755	0.752	-0.356	0.493
PC2 - (Financial motive)	0.389	-0.618	-0.697	1.223
PC3 - (Whole-of-farm value motive)	-0.147	-0.674	0.989	0.131
PC4 - (Household-use motive)	-0.738	-0.131	0.565	0.773
Number in cluster	116	111	102	57
Total area of forested property owned (ha)	191,898	76,525	87,522	14,671

The largest cluster (C1) represents 30.1% of the sample. It appears that members of this cluster view their forest resource exclusively as a source of current income and future wealth and security. Negative mean scores on all other components suggest that these individuals may not view financial motives as being complementary to non-timber output, whole-of-farm values and household-use motives. Members of C1 are referred to as *income and investment growers* throughout the rest of this paper.

The second largest cluster (C2) represents 28.8% of the sample and members of this group emphasise the non-timber output and tourism benefits of their forests. Negative mean scores on financial, whole-of-farm value and household-use motives suggest that members of this group see these motives as incompatible with the non-timber output motives. This cluster is labelled as *non-timber output owners*.

The third largest cluster (C3) is labelled *agriculturalists* and they represent 26.4% of the total sample. This group of landowners value their forests primarily for their contribution to the value of their property as a whole, and to a lesser extent for other household uses.

The smallest cluster (C4) represents 14.8% of the total sample. Positive mean factor scores on all four principal components suggest that members of this group include non-timber output, income and investment potential, whole-of-farm contribution and household-use values in their forest ownership objectives. This group has the highest mean component scores for both financial and household use motives. Members of this group are referred to as *multi-objective owners*⁴.

⁴ Kline *et al.* (2000) and Karppinen (1998) both identified clusters with positive factor scores on all principal components and also labelled them as multi-objective owners. Multi-objective owners comprise the largest cluster in both of these studies.

Almost 52% of the native forest and plantation resource of sample members is owned by *income and investment owners*. *Non-timber output owners* and *agriculturalists* account for about 21% and 23% respectively of the total forested area, while only about 4% of the resource is held by *multi-objective owners*.

The mean values for a range of property- and owner-related variables and the results of the tests of differences between clusters are reported in Table 3. Property size was found to be significantly larger for *income and investment owners* properties (1,669 ha) than *non-timber output* and *multi-objective owners* (689 ha) but not significantly different to *agriculturalists* (858 ha).

Average property size for non-timber output owners (689 ha) and multi objective owners (309 ha) is not significantly different. The properties owned by income and investment owners contained significantly larger areas of native forest (799 ha) and area of plantation (122 ha) than all other groups. However the proportion of the property with forest cover was the same for all groups except for agriculturalists.

Table 3. Results of tests of difference in property and owner characteristics between objective-based landowner clusters

Property characteristic	Landowner clusters				P value
	C1 Income and investment owners	C2 Non- timber output owners	C3 Agricul- turalist	C4 Multi- objective owners	
	Average for cluster ^a				
Property size (ha)	1,669 ^{C2, C4}	689 ^{C1, C3}	858 ^{C2, C4}	309 ^{C1, C3}	.0000
Area of native forest (ha)	799 ^{C2, C4}	316 ^{C1, C4}	309 ^{C4}	167 ^{C1, C2, C3}	.0001
Area of plantation (ha)	122 ^{C2, C3, C4}	66 ^{C1}	31 ^{C1}	25 ^{C1}	.0000
Proportion of total property with forest cover	0.638 ^{C3}	0.658 ^{C3}	0.525 ^{C1, C2}	0.599	.0026
Length of ownership (years)	24	17	22	16	.0554
	Number of respondents (proportion of the cluster population)				
Own another property	61 (.53)	40 (.36)	36 (.35)	10 (.18)	0.0001
Property is mainly used for grazing	67 (.58)	52 (.47)	75 (.74)	30 (.53)	0.0009
Gross farm income is more than \$100,000 per annum	47 (.41)	24 (.22)	26 (.25)	7 (.12)	0.0003
Resident on property	43 (.37)	59 (.53)	57 (.56)	35 (.61)	0.0057
Property owner more than 45 years old	84 (.72)	74 (.67)	68 (.67)	34 (.60)	0.4017
Female landowner	5 (.04)	29 (.26)	17 (.17)	7 (.12)	0.0001
Own the property individually	44 (.38)	61 (.55)	50 (.49)	30 (.53)	0.0603
Post secondary schooling achieved	61 (.53)	75 (.68)	37 (.36)	26 (.46)	0.0000

^a Significantly different landowner cluster.

All tests are conducted using a 5% level of significance.

The proportion of *income and investment owners* (53%) who indicated that they owned another property with some forest cover was significantly larger than for other groups. The annual gross farm income (GFI) exceeded \$100,000 for over 40% of *income and investment owners* but for only 12% of *multi-objective owners*. Grazing was more likely to be the predominant use of the property for *agriculturalists* than for other groups.

The results in Table 3 also suggest that differences exist in landowner characteristics between objective-based groups. Overall, about 50% of landowners were resident on the property. However, less than 40% of *income and investment owners* indicated that they were resident on the property, while over 60% of *multi-objective owners* resided on the property. Approximately 15% of the 386 landowners surveyed were females. However, the proportion of females ranged from only 4% of *income and investment owners* to a high of 26% for *non-timber output owners*. Members of the *non-timber output* group also had, on average, a higher level of educational achievement than all other groups with 68% reporting post-secondary schooling as the highest level attained (60% of these had university qualifications). There was no significant difference at the 5% level between the groups in the length of time the property had been owned, whether the property was owned individually, or the age of the respondent (as measured by the proportion of the group over 45 years of age).

Results of tests of difference for a range of variables reflecting past timber supply behaviour and future logging intentions between landowners belonging to the four objective-based groups are reported in Table 4. These differences are significant at the 5% level for all harvest-related variables other than the past sale of firewood. Between 27% and 33% of *income and investment owners*, *agriculturalists* and *multi-objective owners* indicated that they had harvested timber from the property in the past three years, while only 14% of *non-timber output owners* indicated that they had harvested during this period.

Table 4. Results of tests of difference in forest harvesting behaviour between objective-based landowner clusters

Harvesting variable	C1 Income and investment owner	C2 Non- timber output owners	C3 Agricul- turalists	C4 Multi- objective owners	P value – Chi-square test for independence
Number of respondents (proportion of the cluster population) in past three (3) years have					
Harvested timber from property	38 (.33)	15 (.14)	28 (.27)	16 (.29)	0.0075
Sold sawlogs and/or pulpwood	28 (.24)	6 (.05)	14 (.14)	6 (.11)	0.0006
Sold firewood	10 (.09)	3 (.03)	11 (.11)	7 (.13)	0.0798
Sold timber from other properties	22 (.19)	6 (.05)	20 (.20)	0 (.00)	0.0001
Currently					
Involved in a joint venture or other wood supply agreement	38 (.33)	7 (.06)	14 (.14)	9 (.16)	0.0000
Have a private timber reserve on any part of the property	39 (.34)	7 (.06)	19 (.19)	7 (.13)	0.0000
In next twelve (12) months plan to					
Log for commercial timber sales ^a	30 (.26)	7 (.06)	21 (.21)	8 (.14)	0.0008
Log more than 50 ha	11 (.10)	2 (.02)	9 (.09)	1 (.02)	0.0257
Log sawlogs and/or pulpwood	28 (.24)	6 (.05)	18 (.18)	6 (.11)	0.0007
Log firewood	1 (.01)	0 (.00)	6 (.06)	4 (.07)	0.0078

^a Total numbers may not add up to sample size because some forest owners indicated that they were intending to log for pulp or sawlog products and firewood.

More than 20% of *income and investment owners* and *agriculturalists* indicated an intention to harvest for commercial timber sales in the next 12 months. This contrasts with the 6% of *non-timber output owners* and the 14% of *multi-objective owners* who stated this intention. This pattern of intended harvesting behaviour is reinforced by the findings of an intention to both harvest more than 50 ha and log for commercial sawlog or pulplog sales in the next 12 months. However, *agriculturalists* and *multi-objective owners* appear more likely to harvest for commercial firewood sales in the next 12 months than do either *income and investment owners* or *non-timber output owners*.

Significant differences were also found between objective-based groups concerning involvement in a Private Timber Reserve (PTR) or joint venture arrangement. Again, *income and investment owners* were more likely to be

participants in these arrangements than all other groups, while *non-timber output owners* were least likely to participate in these arrangements.

Results for activities related to timber production and harvesting and to the production of non-timber forest outputs are reported in Table 5 and 6. The proportion of landowners who had not undertaken any timber-production-related forest management activity in the past three years does not differ significantly between landowner groups. Nor is there any difference between groups in the proportion of members who had undertaken tree planting or seeding, weed and pest control, fertilising, pruning or thinning activity within this period, or who received financial assistance to undertake commercial forest management activity.

Table 5. Results of tests of difference in management behaviour related to timber production and harvesting between objective-based clusters

Forest management variable	C1 Income and investment owners	C2 Non-timber output owners	C3 Agriculturalists	C4 Multi-objective owners	P value— Chi-square test for independence
Number of respondents (proportion of the cluster population) in the past three years have undertaken:					
No forest management activities	55 (.48)	61 (.55)	61 (.60)	36 (.64)	0.1591
More than three activities	18 (.16)	4 (.04)	5 (.05)	5 (.09)	0.0052
Roading	32 (.28)	12 (.11)	17 (.17)	9 (.16)	0.0100
Preparation of THP/FPP ^a	37 (.32)	7 (.06)	12 (.12)	7 (.13)	0.0000
Site preparation for forest establishment	17 (.15)	5 (.05)	3 (.03)	2 (.04)	0.0017
Tree planting and/or seeding	21 (.18)	18 (.16)	10 (.10)	12 (.21)	0.2200
Weed and pest control	28 (.24)	30 (.27)	20 (.20)	14 (.25)	0.6482
Fertilising	14 (.12)	6 (.05)	6 (.06)	7 (.13)	0.1588
Pruning	10 (.09)	3 (.03)	3 (.03)	3 (.05)	0.1430
Thinning	8 (.07)	10 (.09)	5 (.05)	2 (.04)	0.4834
In past three years have received:					
Financial assistance to undertake commercial forest management activities	8 (.07)	1 (.01)	5 (.05)	1 (.02)	0.0921

^a THP is a Timber Harvesting Plan and FPP is a Forest Practices Plan.

Highly significant differences were found in roading, site preparation, timber harvesting and FPP planning activity between the groups, with income and investment owners being the most likely to have undertaken these activities in the past three years. With respect to the level of involvement in commercial timber production activities by the number of activities an individual had undertaken in the past three years, it was

found that the proportion of income and investment owners who had undertaken more than three different activities (16%) was significantly higher than for any other group.

Table 6. Results of tests of difference in management behaviour related to production of non-timber values between objective-based landowner groups

Forest management variable	C1 Income and investment owners	C2 Non-timber output owners	C3 Agriculturalists	C4 Multi-objective owners	P value—Chi-square test for independence
Number of respondents (proportion of the cluster population) who in the past three years have undertaken:					
No forest management activity	73 (.63)	55 (.50)	67 (.66)	33 (.59)	0.0801
More than three activities	8 (.07)	14 (.13)	2 (.02)	3 (.05)	0.0220
Tree planting for vegetation, soil, water conservation	20 (.17)	29 (.26)	10 (.10)	9 (.16)	0.0188
Tree planting for shelter	25 (.22)	27 (.24)	26 (.25)	8 (.14)	0.3693
Tree planting for landscaping	15 (.13)	31 (.28)	15 (.15)	10 (.18)	0.0187
Improvement of forest vegetation for wildlife habitat and/or forest recreation	10 (.09)	28 (.25)	4 (.04)	9 (.16)	0.0000
Fencing native vegetation	22 (.19)	27 (.24)	18 (.18)	7 (.13)	0.2833

As indicated in Table 6, significant differences were found between groups in the proportion of individuals who had undertaken more than three non-timber production forest management activities in the past three years. There is no significant difference in the behaviour of the groups with respect to tree planting for shelter and the fencing of native vegetation. There are however highly significant differences in the behaviour of the groups in their tree planting for vegetation, soil, water conservation and landscaping, and improvement of forest vegetation for wildlife habitat and forest recreation activity, with non-timber output owners being the most likely to have undertaken these activities. With respect to level of involvement in forest management activities aimed at promoting non-timber forest values by the number of activities an individual had undertaken in the past three years⁵, it was found that the proportion of non-timber output owners who have undertaken more than three different activities (13%) is significantly higher than for any other group.

⁵ The survey did not ask whether respondents had undertaken these activities more than once in this period.

DISCUSSION

The statistical analysis allows Tasmanian NIPF owners to be grouped on the basis of the similarity of their stated support for various forest owner objectives. On the basis of a K-means cluster analysis of respondents' factor scores resulting from a principal component analysis of the 18 original objectives, four clusters of landowner groups have been identified. These groups are labelled as income and investment owners, non-timber output owners, agriculturalists, and multi-objective owners. Income and investment owners are driven solely by financial motives in owning their forest resource. Non-timber output owners are motivated by the non-timber outputs of their forest, while agriculturalists are guided by whole-of-farm and household-use motives. Multi-objective owners value all aspects of forest ownership as reflected by a positive factor score for all four principal components.

The landowner groups identified here are similar to those identified in comparable studies. Using the same methodology, Kline *et al.* (2000) also identified four NIPF owner types in the Pacific Northwest of the USA, labelled timber producers, multi-objective owners, recreationalists and passive owners. Although based on a different initial list of forest ownership objectives, timber producers and *income and investment owners*, and recreationalists and *non-timber output owners*, share broadly similar characteristics. Kline *et al.*'s multi-objective owners and the group identified in the Tasmanian study both include timber investment and non-timber values in their forest ownership objectives. However, while multi-objective owners accounted for over 40% of those surveyed in the Kline *et al.* study, they comprised only 18% of the Tasmanian sample. There is also some correspondence between the groups identified here and those found by Emtage *et al.* (2001). In particular, *agriculturalists* and *income and investment owners* correspond broadly to the groups labelled 'traditional' and 'experienced' owners in the earlier study.

Using a list of 21 ownership objectives, Karppinen (1998) investigated NIPF owner objectives in Finland and also found four landowner types, namely multi-objective owners, recreationalists, self-employed owners and investors. While sharing many characteristics with the *agriculturalist* group of the Tasmanian study, the self-employed owners in Karppinen's study appear not to have the same focus on the role of forests in enhancing whole-of-farm value. In Karppinen's study recreationalists were the largest group, while investors comprised only 13% of landowners surveyed compared with over 30% in the Tasmanian study. In a study of NIPF owners in the Missouri Ozarks, Kurtz and Lewis (1981) also identified four types of owners using a Q-sort analysis of forestland management objective and motivation statements. These groups were timber agriculturalists, timber conservationists, forest non-timber output owners and range pragmatists.

The Tasmanian analysis of how members of these groups differ in terms of their personal and property characteristics, as well as their timber harvesting and management behaviour, established a number of significant relationships. For example, *income and investment owners* tended to own larger properties than all other groups apart from agriculturalists, as well as larger holdings of both native forest and plantations. This group was also more likely to own another forested property and earn annual gross farm income of more than \$100,000. On the other hand, *multi-objective owners* tended to own smaller properties, with associated

smaller holdings of native forest than all other groups. They were also less likely to own another property or to earn annual GFI in excess of \$100,000. Other than the importance of grazing activity, there appears to be no difference between *non-timber output owners* and *agriculturalists* in terms of the property characteristics examined in this study. A significantly lower proportion of the property was covered in forest in the *agriculturalist* group than the *income and investment owners* and the *non-timber output owners*. These results are generally consistent with those reported in Karppinen (1998) and Kline *et al.* (2000). Kline *et al.* found that timber producers tended to own larger tracts of forestland than either recreationists or passive owners⁶.

Overall, the current study found that *non-timber output owners* are more likely to be female⁷ and have a post-secondary education than other landowner types, while *income and investment owners* are more likely to be male and non-resident on the property than other groups. *Agriculturalists* were characterised by having the lowest probability of having attained post-secondary education. Kline *et al.* (2000) also found that 'recreationists'⁸ tend to fall in higher education categories' and Karppinen (1998) found that the probability of belonging to the investors increased with a college or academic education and the probability of belonging to the self-employed owners fell with increased education. Previous studies also support the findings on the relationship between residence on holding and landowner type.

In the current study, landowner groups could not be statistically characterised by either the duration of property ownership or their age. The apparent lack of importance of age of the owner in explaining landowner type is inconsistent with Karppinen (1998) and Kline *et al.* (2000) who found that timber producers tend to fall in the higher age categories.

The Tasmanian results reveal differences in past and intended harvesting behaviour between the four landowner groups. A significantly higher proportion of *income and investment owners* indicated having harvested timber in the past three years, and an intention to log for commercial timber sales in the next 12 months. *Non-timber output owners* are the least likely to have either logged in the past or intend logging in the future. This suggests that an emphasis on financial returns does underlie differences in harvesting behaviour in Tasmania. Such a pattern is not reported in either Kuulvainen *et al.* (1996) or Karppinen (1998) both studies of which compared harvesting behaviour across groups and found that multi-objective owners have been the most active harvesters. Nevertheless, recreationists were found to harvest less for sale than all other forest owners in both these studies.

The pattern of harvesting activity and intentions across groups is mirrored in the likelihood of being involved in both a Private Timber Reserve (PTR) and joint venture or other wood supply agreement. In Tasmania, PTRs are directly linked to timber harvesting, and the analysis reveals that *income and investment owners*, who

⁶ Kline *et al.* (2000) also found that multi-objective owners tend to have larger tracts of land.

⁷ Gender here is that of the survey respondent, which may not be consistent with a high level of decision-making power or influence within the household.

⁸ Recreationists had a positive factor score for 'recreation' which includes reasons (objectives) such as 'estate to pass on to children', 'forest is part of residence', 'enjoyment of green space', 'recreation' and 'land investment'. These objectives differ from those used in this study.

on average have higher harvesting intentions, are significantly more likely to have a PTR on their properties than all other landowner groups. This was also found by Marty *et al.* (1988) who reported that completion of a timber inventory⁹ is most likely to be associated with owners oriented towards timber production.

Income and investment owners were also found to undertake significantly more forest management activities aimed at timber production compared to other landowner groups (in particular site preparation for forest establishment, preparation of a THP/FPP, and roading). *Non-timber output owners* and *agriculturalists* are least likely to have invested in these activities. This pattern was also reported by Kurtz and Lewis (1981), Marty *et al.* (1988) and Karppinen (1998). However, multi-objective owners in Karppinen's study were the most active group in terms of the number of silvicultural activities undertaken in the past five years.

Differences in whether landowners had accessed financial assistance for commercial silvicultural activity are only significant at the 10% level. *Income and investment owners* and *agriculturalists* are more likely to have received assistance than either *non-timber output owners* or *multi-objective owners*.

Non-timber output owners are more involved in activities directly aimed at promoting conservation, aesthetics and biodiversity than other landowner groups. The difference in involvement in practices aimed at improving forest vegetation for wildlife habitat and/or forest recreation was pronounced, with only 4% of *agriculturalist* and 9% of *income and investment owners* indicating their participation in this activity. Emtage *et al.* (2001) found that 'retired professionals and hobby farmers' were most likely to intend to plant trees for aesthetic and environmental reasons, amongst other things. *Non-timber output owners* display some characteristics of 'hobby farmers' as described by Emtage *et al.* (2001). No significant differences were detected between the landowner groups in tree planting for shelter and fencing native vegetation activities, although *agriculturalists* were the most active group in planting for shelter, an activity with direct whole-of-farm value benefits. Interestingly, despite being a central focus of agricultural extension in Tasmania, only 10% of *agriculturalists* reported having planted trees for vegetation, soil and water conservation.

This study has confirmed that distinct types of NIPF owners exist in Tasmania and that they can be clearly characterised by their objectives for forest ownership. Importantly, members of these owner groups can be distinguished by a range of readily observable property and personal owner variables. The analysis also suggests that the timber harvesting and forest management behaviour of these groups differs. Overall, *income and investment owners*, who value forests exclusively for their ability to serve financial objectives, are more active forest harvesters and invest more in forest management activities intended to promote and facilitate timber production. *Agriculturalists* had similar future harvesting intentions, and were only slightly less active harvesters in the past, as compared with *income and investment owners* while being different in respect to property and personal characteristics. These results were not found in any of the other international studies. A high proportion of landowners in Tasmania combine agricultural activities with occasional 'opportunistic' timber harvesting.

⁹ This is approximately the equivalent of a PTR in the USA.

Non-timber output owners support their emphasis on non-timber output objectives by being the least active harvesters and by having the highest level of involvement in conservation-related forest management activities.

CONCLUDING COMMENTS

Ultimately, the value in understanding the objectives of forest owners lies in improving our ability to encourage forest owners, either directly or indirectly, to improve forest management practices and to produce a socially optimal mix of timber and non-timber forest outputs. Knowing the nature of homogeneous landowner groups can help program managers tailor incentive programs to appeal to individual landowners and can assist the forest industry in its interactions with non-industrial growers. Furthermore, if as the results of this study indicate, landowner type is a significant determinant of timber supply and conservation behaviour, economists will want to incorporate information about landowner attitudes and objectives in models explaining the supply of timber and non-timber outputs.

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